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Does hypsometry necessarily invalidate the cooling-plate model?

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Plots of oceanic depth (z) vs. crustal age (t) for 'normal' seafloor are well explained by depth-age predictions of thermal contraction models such as the cooling plate model. Hypsometry, however, cannot be so explained. Variability within age-bands exists, implying that deterministic models that predict z from t are not alone sufficient to explain the data. Stochastic events reheating a cooling boundary layer have been invoked to explain the variability, obviating the need for a plate model. However, crustal thickness variations, via isostasy, are shown here to be able to cause much of the variability, so the plate model need not necessarily be rejected.

In the Pacific as a whole $\pm$280 m (1σ) of random depth variability is necessary to reconcile a plate model z-t relationship and hypsometry. 'Normal' oceanic lithosphere has a crustal thickness of 7.1$\pm$0.8 (1σ) km, with a range of 5.0-8.5 km (White, 1992), capable of isostatically explaining $\sim$450 m of seafloor depth variation [ρ_c = 2950 kgm^{-3}, ρ_w = 1030 kgm^{-3}, ρ_m = 3300 kgm^{-3}]. These thicknesses correlate (p $>$ 0.98) with depth anomalies from a depth-age curve for 'normal' seafloor approximated as z = 3010 + 307$\sqrt{t}$ ($t < 85$ Ma) then z = 6120 - 3010 exp(-0.026t). The implication is that crustal thickness variations within the 'normal' range cause a substantial part of the variation. Furthermore, qualitatively, depth anomalies in the NE Pacific appear at least partially related to Fracture Zones, and few hot-spots swells are known, yet $\pm$230 m (1σ) of variability is present. Thus a cooling plate carrying ridge-generated crustal thickness variations should not be rejected yet, and further explored before invoking mechanisms with a deeper origin. Doubt is also cast upon the 'planform of mantle convection' previously seen in bathymetry.